

TABLE 10.2 Physical properties of alcohols

| COMPOUND   | NAME                       | mp<br>(°C) | bp<br>(°C)<br>(1 atm) | DENSITY<br>$d_4^{20}$ (g mL <sup>-1</sup> ) | WATER<br>SOLUBILITY<br>(g 100 mL <sup>-1</sup> H <sub>2</sub> O) |
|--|----------------------------|------------|-----------------------|---|--|
| <b>Monohydroxy Alcohols</b>  |                            |            |                       |   |  |
| CH <sub>3</sub> OH   | Methanol                   | - 97       | 64.7                  | 0.792                                       | ∞  |
| CH <sub>3</sub> CH <sub>2</sub> OH                                 | Ethanol                    | - 117      | 78.3                  | 0.789                                       | ∞  |
| CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> OH                 | Propyl alcohol             | - 126      | 97.2                  | 0.804                                       | ∞  |
| CH <sub>3</sub> CH(OH)CH <sub>3</sub>                              | Isopropyl alcohol          | - 88       | 82.3                  | 0.786                                       | ∞  |
| CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> OH | Butyl alcohol              | - 90       | 117.7                 | 0.810                                       | 8.3  |
| CH <sub>3</sub> CH(CH <sub>3</sub> )CH <sub>2</sub> OH             | Isobutyl alcohol           | - 108      | 108.0                 | 0.802                                       | 10.0   |
| CH <sub>3</sub> CH <sub>2</sub> CH(OH)CH <sub>3</sub>              | <i>sec</i> -Butyl alcohol  | - 114      | 99.5                  | 0.808                                       | 26.0   |
| (CH <sub>3</sub> ) <sub>3</sub> COH                                | <i>tert</i> -Butyl alcohol | 25         | 82.5                  | 0.789                                       | ∞  |
| CH <sub>3</sub> (CH <sub>2</sub> ) <sub>3</sub> CH <sub>2</sub> OH | Pentyl alcohol             | - 78.5     | 138.0                 | 0.817                                       | 2.4  |
| CH <sub>3</sub> (CH <sub>2</sub> ) <sub>4</sub> CH <sub>2</sub> OH | Hexyl alcohol              | - 52       | 156.5                 | 0.819                                       | 0.6  |
| CH <sub>3</sub> (CH <sub>2</sub> ) <sub>5</sub> CH <sub>2</sub> OH | Heptyl alcohol             | - 34       | 176                   | 0.822                                       | 0.2  |
| CH <sub>3</sub> (CH <sub>2</sub> ) <sub>6</sub> CH <sub>2</sub> OH | Octyl alcohol              | - 15       | 195                   | 0.825                                       | 0.05   |
| CH <sub>3</sub> (CH <sub>2</sub> ) <sub>7</sub> CH <sub>2</sub> OH | Nonyl alcohol              | - 5.5      | 212                   | 0.827                                       |  |
| CH <sub>3</sub> (CH <sub>2</sub> ) <sub>8</sub> CH <sub>2</sub> OH | Decyl alcohol              | 6          | 228                   | 0.829                                       |  |
| CH <sub>2</sub> =CHCH <sub>2</sub> OH                              | Allyl alcohol              | - 129      | 97                    | 0.855                                       | ∞  |
| (CH <sub>2</sub> ) <sub>4</sub> CHOH                               | Cyclopentanol              | - 19       | 140                   | 0.949                                       |  |
| (CH <sub>2</sub> ) <sub>5</sub> CHOH                               | Cyclohexanol               | 24         | 161.5                 | 0.962                                       | 3.6  |
| C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> OH                   | Benzyl alcohol             | - 15       | 205                   | 1.046                                       | 4  |
| <b>Diols and Triols</b>  |                            |            |                       |   |  |
| CH <sub>2</sub> OHCH <sub>2</sub> OH                               | Ethylene glycol            | - 12.6     | 197                   | 1.113                                       | ∞  |
| CH <sub>3</sub> CHOHCH <sub>2</sub> OH                             | Propylene glycol           | - 59       | 187                   | 1.040                                       | ∞  |
| CH <sub>2</sub> OHCH <sub>2</sub> CH <sub>2</sub> OH               | Trimethylene glycol        | - 30       | 215                   | 1.060                                       | ∞  |
| CH <sub>2</sub> OHCHOHCH <sub>2</sub> OH                           | Glycerol                   | 18         | 290                   | 1.261                                       | ∞  |

Ethers, however, are able to form hydrogen bonds with compounds such as water. Ethers, therefore, have solubilities in water that are similar to those of alcohols of the same molecular weight and that are very different from those of hydrocarbons.

Diethyl ether and 1-butanol, for example, have the same solubility in water, approximately 8 g per 100 mL at room temperature. Pentane, by contrast, is virtually insoluble in water.

Methanol, ethanol, both propyl alcohols, and *tert*-butyl alcohol are completely miscible with water (Table 10.2). The remaining butyl alcohols have solubilities in water between 8.3 and 26.0 g per 100 mL. The solubility of alcohols in water gradu-